

SYSTEM AND METHOD FOR
MULTI-TELECOMMUNICATION OVER LOCAL IP NETWORK

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to telephony over a local IP (Internet Protocol) network, and in particular, to a system and method for conducting a telephone call for a plurality of users over a local IP network to which a single IP address is assigned. The present application is based on Korean Patent Application No. 14102/2000 filed on March 20, 2000, which is incorporated herein by reference.

2. Description of the Related Art

FIG. 1 is a block diagram of a conventional system for telephony over an IP network, FIG. 2 illustrates protocols for telephony in a terminal of the conventional system, FIG. 3 is a signal flow diagram for discovering a gatekeeper in the conventional system, and FIG. 4 is a signal flow diagram for a call process in the conventional system.

Referring to FIG. 1, a VOIP (Voice Over Internet Protocol)-based telephone call is conducted over an IP network 110 according to the ITU-T

(International Telecommunication Union-Telecommunication Sector)
Recommendation H.323.

A gatekeeper 120 acts as a server for conversion between a telephone
number input by an end user and an IP address, and provides registration,
5 authentication, and RAS (Registration Admission Status) management.
Computers 150 and 151 are assigned to unique IP addresses and connected to
the IP network 110. The IP network 110 is connected to the PSTN (Public
Switched Telecommunication Network) 180 and 181 via gateways 190 and
191, respectively. An I-PHONE 160 is an Internet phone for an Internet call.

10 H.323 provides protocols as shown in FIG. 2. According to H.323, a
communication is conducted by TCP (Transmission Control Protocol) 210 or
UDP (User Data Protocol) 220 based on IP (Internet Protocol) 200.

To attempt connection of an initial call, call signaling is performed
according to H.225 (Q.931) 211, call control according to H.245 212, and data
15 transmission according to T.120 213. H.225, H.245, and T.120 are based on
TCP 210.

After call connection, G.7XX 221 controls voice transmission and
H.26X 222 controls video transmission. G.7XX and H.26X are processed by
RTP (Real Time Protocol) 223 for real-time transmission, and RTCP (real-
20 time transport control protocol) 224 controls an RTP channel. G.7XX, H.26X,
RTP, and RTCP are based on UDP 220. TCP requests an acknowledgment
and UDP transmits data regardless of the acknowledgment. UDP 220

processes voice or video data because its slight loss is negligible to a user in data recovery.

Referring to FIG. 3, a description will be made of an operation of discovering the gatekeeper 120 for a telephone call over the IP network 110 in the computer 150.

In step 300, the computer 150 transmits a gatekeeper request message GRQ using a multicast address by UDP in order to discover the gatekeeper 120. The gatekeeper 120 transmits a gatekeeper confirm message GCF to the computer 150 as a response to the gatekeeper request message GRQ in step 310. The gatekeeper confirm message, GCF contains the IP address of the gatekeeper 120. Upon receipt of the gatekeeper confirm message GCF, the computer 150 transmits a registration request message RRQ to the gatekeeper 120, thereby registering a Q.931 transport address (IP address + TCP port number) and an alias address of the computer 150 and the IP address of a destination (i.e., a receiving computer). The alias address is registered when a local IP network is assigned to a plurality of IP addresses. Such a local IP network dynamically allocates the IP addresses to computers connected to the local IP network upon request of Internet access and a gatekeeper registers the IP addresses assigned to the computers.

When registration is completed, the gatekeeper 120 transmits a registration confirm message RCF to the computer 150 in step 330. For this purpose, the ITU-T defines UDP and TCP channels as shown in Table 1 below.

Table 1

GATEKEEPER DISCOVERY MULTICAST ADDRESS	224.0.1.41
GATEKEEPER UDP DISCOVERY PORT	1718
GATEKEEPER UDP REGISTRATION AND STATUS PORT	1719
ENDPOINT TCP CALL SIGNALLING PORT (in the case of direct call signaling to an endpoint without a gatekeeper)	1720

A procedure subsequent to the registration will be described with reference to FIG. 4.

Referring to FIG. 4, the computer 150 transmits an admission request message ARQ to the gatekeeper 120 in step 400 and the gatekeeper 120 transmits an admission confirm message ACF to the computer 150 in response to the admission request message ARQ as long as the receiving computer is not busy. Then, the computer 150 opens a TCP channel for call signaling according to Q.931 in step 420 and transmits its transport address to the computer 151, thereby requesting connection in step 430. The computer 151 transmits the admission request message ARQ to the gatekeeper 120 in order to request a connection admission. In step 450, the gatekeeper 120 transmits the admission confirm message ACF to the computer 151. After the call connection is admitted, the computer 150 transmits an H.245 transport address to the computer 151, thereby notifying completed connection in step 460. The

computer 150 opens a TCP channel for H.245 in step 470 and establishes an RTP/RTCP channel for a voice or video call in real time by exchanging H.245 messages in step 480. Then, the call progresses by UDP in step 490.

The above call process has been described in the context of the ITU-T
5 recommendations and its detailed description is omitted here.

Telephony over the IP network is viable on the premise that each terminal (computer, Internet phone, etc.) is assigned to a unique IP address. In other words, a terminal connected to a local IP network and having no unique IP address cannot receive/transmit data. When a telephone call is conducted
10 over the IP network, each IP address functions as a telephone number. Therefore, a computer without an IP address cannot conduct a telephone call.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a system and method for conducting a telephone call using a single IP address in a
15 plurality of terminals connected to a local IP network.

It is another object of the present invention to provide a system and method for interfacing between a terminal connected to an IP network and a terminal connected to a local IP network when a plurality of terminals connected to the local IP network conduct telephone calls using a single IP
20 address.

To achieve the above and other objects, there is provided a system and method for multi-telecommunication over a local IP network. The multi-

telecommunication system includes an IP network, a local IP network, a plurality of terminals connected to the local IP network, for conducting a voice call or a video call over the local IP network, a home gateway connected to the IP network and the local IP network, for interfacing between the IP network and the plurality of terminals, assigning an ID and a port to each terminal to differentiate terminals sharing one IP address in processing an incoming call and an outgoing call, and converting IP and port information in the header and payload of a received or transmitted packet according to an assigned ID and port number, and a gatekeeper connected to the IP network, for performing registration and call connection admission and managing the state of the IP network.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings in which:

FIG. 1 is a block diagram of a conventional system for conducting a VOIP-based telephone call;

FIG. 2 illustrates the structure of protocols for a telephone call in a terminal of the conventional system;

FIG. 3 is a signal flow diagram for discovering a gatekeeper in the conventional system;

FIG. 4 is a signal flow diagram for a telephone call process in the conventional system;

FIG. 5 illustrates a multi-telecommunication system according to an embodiment of the present invention;

5 FIG. 6 illustrates the structure of protocols for a home gateway according to the embodiment of the present invention;

FIG. 7 is a signal flow diagram for discovering a gatekeeper according to the embodiment of the present invention;

10 FIG. 8 is a signal flow diagram for registration in the gatekeeper according to the embodiment of the present invention;

FIG. 9 is a signal flow diagram for a telephone call process according to the embodiment of the present invention;

FIG. 10 is a signal flow diagram for protocol conversion in the home gateway;

15 FIG. 11 is a flow chart for processing an incoming call according to the embodiment of the present invention; and

FIG. 12 is a flow chart for processing an outgoing call according to the embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

20 A preferred embodiment of the present invention will be described hereinbelow with reference to the accompanying drawings. In the following

description, well-known functions or constructions are not described in detail since they would obscure the invention in unnecessary detail.

Referring to FIGs. 5 and 6, a multi-telecommunication system according to an embodiment of the present invention will be described. In FIG. 5, a home gateway 100, which controls a plurality of computers 102 to 109 via a local IP network 101, executes a different function from that of a conventional home gateway as shown in FIG. 1. Only protocol conversion is executed in the conventional home gateway to interface between the IP network 110 and the computers 150 and 151. That is, externally input packets of TCP/UDP 610, IP 620, and MAC (medium access control) 630 are converted to packets of TCP'/UDP' 611, IP' 621, and MAC'631 for connection to the local IP network 110. However, the home gateway 100 additionally provides packet conversion according to the ITU-T Recommendation H.323. Therefore, the home gateway 100 converts both the header and payload of a packet by referring to a predetermined table.

The local IP network 101 is usually assigned to less IP addresses in number than the computers 102 to 109 on the assumption that all the computers 102 to 109 are not connected to the IP network 110. Hence, the home gateway dynamically assigns the IP addresses to computers that request access to the IP network, which implies that a different IP address is assigned to a computer depending on the situation. Consequently, the computers 102 to 109, dynamically assigned to IP addresses, cannot access the IP network for call connection. To overcome the problem, the home gateway 100

differentiates computers that share an identical IP address by port numbers in order to conduct a telephone call over the IP network 110 in the present invention.

In general, an IP address in an IP network serves as a telephone
5 number to identify an end user. However, an IP address assigned to the local IP network 101 acts as a local number and a port number, as well as a telephone number. Table 2 below shows how the home gateway 100 identifies the computers 102 to 109 connected to the local IP network 101. The home gateway 100 can, for example, include a memory for storing the
10 Ids, and port numbers.

Table 2

Terminal	Assigned IP Address	Internal IP Address	Assigned port Number
Terminal #1	203.234.47.18	10.0.0.0	6
Terminal #2	203.234.47.18	10.0.0.1	7
Terminal #3	203.234.47.18	10.0.0.2	8
.	203.234.47.18	.	.
.		.	.
.		.	.
Terminal #9	203.234.47.18	10.0.0.8	11
Terminal #10	203.234.47.19	10.0.255.1	6
Terminal #11	203.234.47.19	10.0.255.2	7
Terminal #12	203.234.47.19	10.0.255.3	8
.	203.234.47.19	.	.
.		.	.
.		.	.
Terminal #N	203.234.47.19	10.0.255.255	P

As shown in Table 2, the local IP network 101 connected to the IP network 110 has N terminals and is assigned to two IP addresses, 203.234.47.18 and 203.234.47.19. Each IP address is shared by a plurality of terminals. The local IP network 101 identifies each terminal by an internal IP address, that is, 10.0.0.0 to 10.0.255.255. According to the embodiment of the

present invention, each terminal is assigned to a different port number to make a distinction between the terminals of the local IP network 101. Here, a port refers to a TCP/UDP port, not in a physical or hardware sense. In general, an IP network assigns particular ports to process HTTP, E-mail, and FTP and has a plurality of reserved ports. These reserved ports are used as IDs to identify the terminals connected to the local IP network 101 in the embodiment of the present invention. By the port numbers, the IP network 110 and the computers 150 and 151 connected to the IP network 110 identify the computers 102 to 109 connected to the local IP network 101. The ports may be assigned by a network operator. Information about assigned ports and IP addresses are stored in a memory for use in packet conversion. Assigned and updated port numbers and IP addresses are transmitted to and registered in the gatekeeper 120 that manages the IP network 110.

A packet is typically divided into a header indicating a destination and a source and a payload containing real user data. When H.323 is used for a voice call or a video call, the IP, TCP, and UDP information of a destination is included in the payload as well as in the header of a packet. Therefore, when only the header is changed, a terminal just notifies the presence of an error by an error check on the payload, and does not conduct a call. The home gateway 100 changes the information of the header and payload according to predetermined values (Table 2), to thereby conduct a telephone call.

Now, call initiation and call termination will be described.

FIG. 7 is a signal flow diagram for discovering the gatekeeper 120. Referring to FIG. 7, the home gateway 100 operates to discover the gatekeeper 120 of the IP network 110 in step 700. This step is performed in a similar manner to the conventional method.

5 In step 700, the computer 102 connected to the local IP network 101 transmits a gatekeeper request message GRQ' to the home gateway 100. The home gateway 100 converts a GRQ' packet to a GRQ packet referring to Table 2 and transmits the GRQ packet to the IP network 110 in step 710. The packet conversion represents changing the contents of the header and payload
10 of the GRQ' packet. " ' " of GRQ' indicates a packet generated in the local IP network 101 or a packet directed to a terminal connected to the local IP network 101.

The packet conversion will be described with an example taken. The computer 102 transmits a packet for a telephone call to the home gateway 100.
15 The header of the packet includes a multicast IP address to discover the gatekeeper 120 and an internal IP address assigned to the computer 102 by the local IP network 101. Then, the home gateway 100 changes the internal IP address to an IP address assigned to the local IP network 101 by the IP network 110 and writes a port number assigned for a telephone call in the
20 payload as well as in the header of the packet, and transmits the converted packet to the IP network 110.

Upon receipt of the gatekeeper request message GRQ from the IP network 110, the IP network 110 transmits the gatekeeper confirm message

GCF, including the IP address of the gatekeeper 120, to the home gateway 100 in step 720. The message GCF is transmitted to a corresponding IP address and port number according to the information of the GRQ packet. If H.323 is used, information in the payload of the GCF packet is also determined according to the received GRQ packet. Upon receipt of the gatekeeper confirm message GCF, the home gateway 100 checks whether there is a terminal with the corresponding IP address and port number referring to Table 2. If the terminal exists, the home gateway 100 detects an internal IP address assigned to the port, converts the IP and port information of the header and payload in the GCF packet, and transmits the converted GCF' packet to the computer 102 in step 730.

In steps 701, 711, 721, and 731, another computer 109 searches for the gatekeeper 120. Their description will be omitted herein. As shown in Table 2, terminals connected to the local IP network are differentiated by different ports though they use the same IP address assigned to the local IP network. The ports are TCP/UDP ports as shown in FIG. 6 and different or the same ports may be used for TCP and UDP as shown in Table 2. In the embodiment of the present invention, terminals in the local IP network share the same IP address to emphasize that they are differentiated by ports when they communicate with the IP network.

FIG. 8 is a signal flow diagram for registering the computer 102 that requests a call in the gatekeeper 120. In step 800, the computer 102 transmits a registration request message RRQ' to the home gateway 100 to request a

telephone call to the gatekeeper 120. The home gateway 100 converts the RRQ' packet to an RRQ packet referring to Table 2 and transmits the RRQ packet to the gatekeeper 120 in step 810. As stated above, the conversion is performed on the contents of the header and payload of the RRQ' packet. “““

5 of RRQ' indicates that the packet is generated in the local IP network 101 or that the packet is directed to a terminal connected to the local IP network 101.

The packet conversion will be described with an example taken. The computer 102 transmits a packet for registration to the home gateway 100. The header of the packet includes the IP address of the gatekeeper 120 and an
10 internal IP address of the computer 102 assigned by the local IP network 101. Then, the home gateway 100 changes the internal IP address to an IP address assigned to the local IP network 101 by the IP network 110 and writes a port number assigned for a telephone call in the payload as well as in the header of the packet, and transmits the converted packet to the gatekeeper 120.

15 Upon receipt of the gatekeeper request message RRQ, the gatekeeper 120 transmits the registration confirm message RCF to the home gateway 100 in step 820. The message RCF is transmitted to a corresponding IP address and port number according to the information of the RRQ packet. If H.323 is used, the information of the payload of the RCF packet is also determined
20 according to the received RRQ packet. Upon receipt of the registration confirm message RCF, the home gateway 100 checks whether there is a terminal with the corresponding IP address and port number referring to Table 2. If the terminal exists, the home gateway 100 detects an internal IP address

assigned to the port, converts the IP and port information of the header and payload in the RCF packet, and transmits the converted RCF' packet to the computer 102 in step 830.

In steps 801, 811, 821, and 831, another computer 109 is registered in the gatekeeper 120. Their description will be omitted herein.

FIG. 9 is a signal flow diagram for a post-registration procedure. In step 900, the computer 102 transmits an admission request message ARQ', including the IP and port information of a destination, to the home gateway 100. The home gateway 100 converts the ARQ' packet to an ARQ packet referring to Table 2 and transmits the ARQ packet to the gatekeeper 120 in step 910. The gatekeeper 120 detects the IP address and port number of the destination from the received ARQ packet and checks whether the destination terminal is communicable with the computer 102. If the terminal is communicable, the gatekeeper 120 transmits an admission confirm message ACF to the home gateway 100 in step 920.

Packets exchanged in the procedures of FIGs. 7 and 8 and in steps 900, 910, 920, and 930 in FIG. 9 use channels that have been established for communication with the gatekeeper 120.

After the computer 102 gains admission, it transmits a message SETUP', including the IP address and port of the computer 102, to the home gateway 100 in step 940. The home gateway 100 converts the SETUP' packet to a SETUP packet and transmits the SETUP packet to the receiving computer 150 in step 950. The computer 150 gains a connection admission from the

gatekeeper 120 in steps 960 and 970 and transmits a message CONNECT including the IP address and port number of the computer 150 to the home gateway 100 in step 980. The home gateway 100 converts the CONNECT packet to a CONNECT' packet and transmits the CONNECT' packet to the
5 computer 102 in step 990.

Steps 901, 911, 921, ..., and 991 are the same as the above procedure except that a call is terminated in a computer connected to the local IP network. Thus, their description is omitted.

In FIG. 9, messages indicated by single-line arrows are transmitted on
10 channels established for communication with the gatekeeper 120 and messages indicated by double-line arrows are transmitted on channels established for communication with the receiving computer.

When a call is initiated from the IP network 110, information about the address of a receiver has already been registered in the gatekeeper 120
15 according to Q.931. Hence, the home gateway 100 also has the same IP and port information so that the call can be connected to the corresponding terminal according to the received IP and port information and the data of Table 2.

On the other hand, when a call is originated from the local IP network
20 101, the home gateway 100 has address information according to Q.931 and packet conversion information as shown in Table 2 for use in transmitting a packet to the IP network 110.

FIG. 10 is a signal flow diagram for a post-connection procedure. In step A, the computer 102 transmits an RTCP channel message for media transport control and a message OPENLOGICALCHANNEL to the receiving computer 150 via the home gateway 100. Then, the computer 150 transmits an acknowledgment message OPENLOGICALCHANNELACK, including the RTCP channel information of the computer 150, to the computer 102 via the home gateway 100 in steps C and D.

Steps E to H are similar to the above steps except that a call is terminated at a terminal connected to the local IP network from the IP network, which will not be described here.

After RTCP channels are opened in steps A to D or steps E to H, a voice call or a video call is conducted by RTP and RTCP.

The UDP port numbers used differentiate terminals connected to the local IP network 101 like TCP port numbers.

FIG. 11 is a flowchart illustrating an operation of processing a call incoming from the IP network 110 in the home gateway 100. Upon receipt of a packet in step 1100, the home gateway 100 determines the type of the received packet by checking the header of the packet. The home gateway 100 looks up an NAPT (Network Address Port Table) in step 1102. The NAPT is made in the same manner as Table 2 and temporarily exists as long as a terminal connected to the local IP network 101 is connected to the Internet. The NAPT includes IP and port information. In general, the port and IP information generated during the Internet connection and the internal IP

information are deleted when the connection is released. In the embodiment of the present invention, however, information related to a telephone call is preferably preserved for future call termination. If the received packet turns out to have an IP address and a port number identical to Internet connection
5 information in the NAPT in step 1104, the home gateway 100 converts the IP address in the header of the packet to an internal IP address and transmits the received packet to a corresponding terminal connected to the local IP network 110 in step 1106.

If the IP address and port number of the received packet are not
10 identical to any IP address and port number in the NAPT, the home gateway 100 looks up a forwarding table in step 1108. The forwarding table is made for call initiation and call termination, including assigned IP addresses, internal IP addresses, and port numbers, similarly to Table 2.

If the forwarding table has the detected IP address and port number in
15 step 1110, the home gateway 100 converts the received packet referring to the forwarding table and transmits the converted packet to the terminal in step 1112. If the forwarding table does not have the detected IP address and port number, the home gateway 100 discards the received packet in step 1114.

In summary, the home gateway 100 detects the IP address and port
20 number of a destination by analyzing a received packet. If the detected IP address and port number are present in an Internet connection table, the NAPT, the home gateway 100 converts the received packet referring to the table, considering that the received packet is related to the Internet connection

and transmits the converted packet to the destination. If the detected IP address and port number are present in the forwarding table, the home gateway 100 converts the received packet referring to the table, considering that the received packet is related to a telephone call and transmits the converted packet to the destination. If the detected IP address and port number are present neither in the NAPT nor in the forwarding table, the home gateway 100 discards the received packet.

FIG. 12 is a flowchart illustrating an operation of processing an outgoing call of the local IP network 101 in the home gateway 100. Upon receipt of a packet in step 1200, the home gateway 100 determines the type of the received packet by checking the header of the packet. The home gateway 100 looks up the NAPT in step 1202. The NAPT is made in the same manner as Table 2 and temporarily exists as long as a terminal connected to the local IP network 101 is connected to the Internet. The NAPT includes IP and port information. If the received packet has an IP address and a port number that are identical to Internet connection information in the NAPT in step 1204, the home gateway 100 converts the IP address in the header of the packet to an internal IP address and transmits the received packet to the IP network 110 in step 1206.

If the IP address and port number of the received packet are not identical to any IP address and port number in the NAPT, the home gateway 100 looks up a the forwarding table in step 1208. The forwarding table is

made for call initiation and call termination, including assigned IP addresses, internal IP addresses, and port numbers, similarly to Table 2.

If the forwarding table has the detected IP address and port number, the home gateway 100 converts the received packet referring to the forwarding
5 table and transmits the converted packet to the terminal in step 1212. If the forwarding table does not have the detected IP address and port number, the home gateway 100 stores information about the packet in the NAPT, converts the header of the packet, and transmits the converted packet to the IP network 110 in step 1214.

10 In summary, the home gateway 100 detects the IP address and port number of a destination by analyzing a packet received from the local IP network 101. If the detected IP address and port number are present in the NAPT, the home gateway 100 converts the received packet referring to the table, considering that the received packet is related to Internet connection and
15 transmits the converted packet to the IP network 110. If the detected IP address and port number are present in a forwarding table, the home gateway 100 converts the received packet by referring to the table, considering that the received packet is related to a telephone call and transmits the converted packet to the IP network. If the detected IP address and port number are
20 present neither in the NAPT nor in the forwarding table, the home gateway 100 updates the NAPT.

The NAPT and forwarding table may be incorporated into one table and different port numbers may be assigned to Internet connection for a

telephone call and conventional Internet connection (e.g., for data search).

While the IP and port information generated from the conventional Internet connection can be deleted as the Internet connection is released, information related with a telephone call over the Internet is not deleted but preserved or
5 updated when the telephone call information is changed in the gatekeeper 120.

Telephony using an identical IP address has been described. Since use of the same IP address decreases a transmission rate, the number of terminals that use the same IP address simultaneously may be limited. Considering that real-time transmission is essential to a telephone call, the increase in number
10 of terminals sharing the same IP address may make the real-time transmission impossible. Therefore, it is desirable to limit the number of terminals that can share the same IP address to an optimal value.

In accordance with the present invention as described above, upon receipt of a packet from a terminal connected to a local IP network, a home
15 gateway checks whether the packet is for a telephone call. If the packet is for a telephone call, the home gateway converts the header and payload of the packet according to preset IP and port information and transmits the converted packet to an IP network. If the packet is not for a telephone call, it is determined whether the packet is for conventional Internet communication. If
20 the packet is for the conventional Internet communication, the home gateway converts the packet according to preset IP and port information and transmits the converted packet to the IP network. If the packet is neither for a telephone call nor for the conventional Internet communication, the IP address and port

number of the packet are registered for Internet connection. Therefore, a plurality of terminals connected to the local IP network can conduct telephone calls by a single IP address. In this case, terminals connected to the IP network can be interfaced with terminals connected to the local IP network.

- 5 While the invention has been shown and described with reference to a certain preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.